Should WTO Dispute Settlement Be Subsidized?

Sebastian Wilckens*

April 2007

Abstract

This paper develops a model of the WTO dispute settlement process (DSP) to study the recent proposal by legal scholars to subsidize litigation costs. The high cost of litigation, so the argument, is a major obstacle for developing countries to using the DSP to enforce developed countries' compliance with WTO rules. The paper shows that this proposal may be misguided. In particular, a reduction of litigation costs may lead large countries to impose larger trade impediments where before they may have raised barriers only a little. Thus, a cost reduction may even weaken the smaller countries' position in the DSP. Moreover, the model sheds light on the structure of the dark figure of un-accused offenses, suggesting that the observed record of disputes notified to the WTO is systematically biased.

Keywords: Developing Countries, Dispute Settlement, GATT/WTO, Tariff Retaliation, Trade Disputes

JEL Classifications: F13, K33, O19

---

*Correspondence: Department of Economics, Christian-Albrechts-Universität zu Kiel, Wilhelm-Seelig-Platz 1, D-24098 Kiel, Germany, wilckens@economics.uni-kiel.de. I would like to thank Horst Raff, Rolf J. Langhammer, Mathis Klepper, Gunnar Wiedenfels, Simone Alfarano and Michael Thomas as well as participants at the European Trade Study Group Conference in Vienna, the Midwest International Economics Group Conference in Minneapolis and at workshops of the University of Göttingen and the University of Copenhagen for helpful comments and suggestions.

1 Introduction

An essential change in the course of the transformation of the General Agreement on Tariffs and Trade (GATT) to the World Trade Organization (WTO) in 1995 was the institutionalization of a Dispute Settlement System (DSS). From 1995 until the end of 2005 there were 335 disputes notified to the WTO, consisting of 368 individual countries' complaints. The major share of these complaints (222) was filed by high income countries and against high income countries (235), while there have been only 22 complaints and 21 defences by low-income countries.[1] This extremely asymmetric usage of the DSS has been traced back to an institutional bias of the DSS by scholars from the fields of economics, law and politics. A prominent proposal to overcome this supposed bias of the DSS is a reduction of litigation costs.[2]

Apart from the cost reduction proposal, the paper analyzes the supposed bias of the DSP as such. Some empirical studies have already examined whether or not the unbalancedness of the record of disputes with respect to income groups indicates a systematic bias of the DSS against poorer countries. In the pioneering paper by Horn et al. (1999) the hypothesis that a dispute in a given bilateral product-market-pairing (PMP) occurs randomly is tested empirically. The PMP-approach explains the observed pattern of disputes quite accurately, since bigger and richer countries with more PMPs are supposed to be involved in more disputes than smaller and poorer countries with less PMPs. Another empirical paper by Guzman and Simmons (2005) analyzes the pattern of disputes in terms of the complainants' and respondents' GDP. The authors reject the "power hypothesis" which *"...predicts that countries will file fewer complaints if they are poor and politically weak than if they are rich and politically powerful."*[3]

Although these empirical findings basically reject the hypothesis of a biased system, there is reason to believe that an institutional bias exists, even if it does not show up in the data. It is a known result in trade theory that a larger country may improve its welfare

[1]The figures on the notified disputes are taken from the author's own dataset, which is based on the record of disputes on the WTO's website. Income classifications of countries correspond to the Worldbank's classification scheme.

[2]The proposals include legal assistance, financial assistance and the introduction of procedurally simplified "Small Claims" proceedings for complaints of minor value. See for example Busch and Reinhardt (2003) and Footer (2001).

[3]Guzman and Simmons (2005), page 559.

by offending a trade agreement with a smaller trading partner, even if the smaller country retaliates.[4] Moreover, it is an empirically supported thesis that poor countries face higher costs associated with the preparation of a complaint than rich countries do.[5] In the light of just these two arguments it should already become questionable that the observed record of disputes is generated by an unbiased random process. As a matter of fact, up to now there is no information on the dark figure of disputes, which are those cases where a country experienced a violation but did not report it to the WTO. Guzman and Simmons (2005) conclude: *"In the absence of a clear sense of how many cases developing countries 'ought to' have initiated, we really do not know whether these filed cases represent equal access or not."*[6]. Therefore, empirical approaches, that try to shed light on the question of a systemic bias by considering the mere set of observed disputes, seem to be a dead end.

The theoretical literature on trade agreements is dominated by the employment of an infinitely repeated prisoner's dilemma game in order to explain a country's incentive to comply with, or to offend against a trade agreement.[7] The common ground of these models is the assumption that an offense by one of the trading partners leads to non-cooperative behavior of both trading partners in each of the following periods. As a consequence existing trade agreements are assumed and required to be self-enforcing, such that the afore mentioned trigger strategy successfully deters countries from defecting.[8] Thus, in contrast to reality, violation and retaliation remain off-equilibrium-path strategies in these models.

All in all, existing empirical studies' inference is likely to be based on a systematically biased set of observations, while existing theory does not provide any explanation for the occurrence of disputes if one leaves alone the idea that policymakers may be possessed by a *"demon"* who leads them to irrational behavior from time to time.[9]

In order to be able to (i) explain the observed occurrence of trade disputes and (ii)

[4]A classic reference is *"Do Big Countries Win Tariff Wars?"* by Kennan and Riezman (1988).

[5]See Bown (2005), Guzman and Simmons (2005) and Bush and Reinhardt (2003) who argue that costs play an important role in the poorer countries' decision whether or not to file a complaint. See Footer (2001) for a verbal analysis.

[6]Guzman and Simmons (2005), page 591.

[7]Bagwell and Staiger (1999) use a two country approach. Maggi (1999) uses a three country approach of the described fashion.

[8]Bagwell and Staiger (2002), page 99, believe: *"The fundamental deterrent to such behavior, and the deterrent that therefore rests at the foundation of all others, is the fear of initiating a breakdown in the entire cooperative arrangement and thereby causing a 'trade war'."*.

[9]See Kovenock and Thursby (1992).

analyze the effects of the proposed reduction of litigation costs this paper takes a different slant by providing an explicit model of the DSP. The regulations of the Dispute Settlement Understanding (DSU), which governs the rules of retaliation, are taken at face value and applied to a two country tariff setting game. In this setup violation does not necessarily have to be an off-equilibrium strategy. It rather depends upon a country's relative size and the pertinent level of litigation costs whether or not a trade agreement is violated, and whether or not the offended country decides to file a costly complaint.

The remainder of this paper is organized as follows. Section 2 starts by presenting the underlying two country trading environment. After a brief setup of the model's fundamental equations, the rules of the sequential tariff setting game are introduced. The setup is completed by modeling the WTO's provisions of retaliation. Subsequently the game is solved via backward induction, and best response functions are derived in section 3. The equilibria of the game are presented as functions of country size and litigation costs. Moreover, the proposal of a reduction of litigation costs is examined in a comparative static analysis. In section 4 the robustness of the results is verified in the course of an extension of the basic model. Finally section 5 summarizes the results, establishes links to empirical studies in support of the results and points out implications for the dark figure of disputes.

2 The Model

The analysis is based on a trade model with two countries (Home and Foreign) and three goods (x, y and z), which allows for different country or market sizes. The underlying utility functions are assumed to be quasilinear in both countries: $U[x, y, z] = z+u_x[x]+u_y[y]$. While $u_x[\cdot]$ and $u_y[\cdot]$ are assumed to be strictly concave, z is assumed to be a numeraire good with price p_z fixed at unity. Labor is the only factor of production. Good z is produced using a constant returns to scale technology where one unit of labor produces one unit of output. Hence, the wage is fixed at unity as well. Let trade in the numeraire good be determined residually by the condition of balanced trade.

For the sake of simplicity I first analyze a model, where both countries differ only in their demand for one of the two non-numeraire goods. In section 4 the analysis is extended to a more cumbersome model, where demand for both non-numeraire goods is larger in one country. While the first model is designed to analyze different sizes of the markets for a particular good, the second model is designed to analyze differences in country size.

2.1 Setup of the Trading Environment

Home's demand functions are obtained from the quasilinear utility function $U[x, y, z] = z + (ax - \frac{x^2}{2n})\frac{1}{b} + (ay - \frac{y^2}{2})\frac{1}{b}$, while Foreign's underlying utility function is given by $U^*[x, y, z] = z + (ax - \frac{x^2}{2})\frac{1}{b} + (ay - \frac{y^2}{2})\frac{1}{b}$. Since all parameters are assumed to be positive, Home receives more (less) utility from the consumption of good x than Foreign if n is larger (smaller) than unity. An alternative way to think of the setup of this basic model is to assume two different types of consumers in each country. Consumers of type x only derive utility from the consumption of good x and the numeraire good, whereas consumers of type y only derive utility from the consumption of good y and the numeraire good. Assume then that Home has n consumers of type x, while Foreign has one consumer of type x and that there is one consumer of type y in each country.

Home's demand functions for good x and y are given by:

$$D_x[p_x] := (a - bp_x)n \tag{1}$$

$$D_y[p_y] := a - bp_y \tag{2}$$

Foreign's demand functions for good x and y are given by:

$$D_x^*[p_x] := a - bp_x \tag{3}$$

$$D_y^*[p_y] := a - bp_y \tag{4}$$

While both countries have a positive demand for both good x and good y, good x is produced only in Foreign, whereas good y is produced only at Home[10]:

$$S_x^*[p_x] := bp_x \tag{5}$$

$$S_y[p_y] := bp_y \tag{6}$$

[10]The underlying production functions are assumed to exhibit decreasing returns to scale. The production functions for x and y are given by $x[l] = \sqrt{2bl}$ and $y[l] = \sqrt{2bl}$ respectively, where l denotes labor.

Consequently, Home becomes an importer of good x and an exporter of good y, while Foreign becomes an importer of good y and an exporter of good x. Note that the two countries are symmetric except for the multiplicative parameter n, which represents the size of the home market demand for good x. For $n = 1$ the two countries would be completely symmetric, while for $n > 1$, $(n < 1)$ it holds that Home's import demand is larger, (smaller) than Foreign's import demand.

By assumption, each country's sole policy variable is a per unit import tariff on its import good. Home's import tariff on good x is denoted by τ, while Foreign's import tariff on good y is denoted by τ^*. After the introduction of tariffs, demand for each country's import good is given by $D_x[p_x] := (a - b(p_x + \tau))n$ and $D_y^*[p_y] := a - b(p_y + \tau^*)$, respectively. Market clearing conditions are given by $D_x[p_x, \tau] + D_x^*[p_x] = S_x^*[p_x]$ and $D_y[p_y] + D_y^*[p_y, \tau^*] = S_y[p_y]$, respectively. Solving for p_x and p_y yields equilibrium world market prices as functions of the associated import tariffs:

$$\hat{p}_x[\tau] = \frac{a + an - bn\tau}{2b + bn}, \qquad \hat{p}_y[\tau^*] = \frac{2a}{3b} - \frac{\tau^*}{3}$$

Substituting the equilibrium prices into each country's demand and supply functions yields the equilibrium quantities as functions of the import tariffs:

$$\hat{x}[\tau] = \frac{n(a - 2b\tau)}{2 + n}, \qquad \hat{y}[\tau^*] = \frac{1}{3}(a - 2b\tau^*)$$

Consumer surplus in sector x at Home is $\widehat{cs}_x[\tau] = \frac{n(a-2b\tau)^2}{2b(2+n)^2}$, and Home's tariff revenue is $\widehat{tr}[\tau] = \frac{n\tau(a-2b\tau)}{2+n}$. Home's consumer surplus in sector y is $\widehat{cs}_y[\tau^*] = \frac{(a+b\tau^*)^2}{18b}$. Producer surplus of Home's exporting industry is $\widehat{ps}_y[\tau^*] = \frac{(-2a+b\tau^*)^2}{18b}$. All in all, Home's equilibrium welfare depends upon its own import tariff τ , Foreign's import tariff τ^* and the market size parameter n:

$$\hat{w}[\tau, \tau^*, n] = \frac{1}{18}(\frac{5a^2}{b} - 2a\tau^* + 2b\tau^{*2}) + \frac{n(a - 2b\tau)(a + 2b(1+n)\tau)}{2b(2+n)^2} \qquad (7)$$

Foreign's equilibrium welfare is obtained in an analogous manner. It is as well a function of

Home's import tariff τ, Foreign's import tariff τ^* and the market size parameter n:

$$\hat{w}^*[\tau, \tau^*, n] = \frac{a^2 + 2ab\tau^* - 8b^2\tau^{*2}}{18b} + \frac{a^2(2 + 2n + n^2) - 2abn^2\tau + 2b^2n^2\tau^2}{2b(2+n)^2} \tag{8}$$

Both welfare functions are strictly concave in each country's own tariff and decreasing in the other country's tariff.[11] The pair of optimal tariffs τ_o and τ_o^* is given by:

$$\tau_o[n] = \frac{an}{4b + 4bn} \tag{9}$$

$$\tau_o^* = \frac{a}{8b} \tag{10}$$

While Foreign's optimal tariff is a constant, Home's optimal tariff is an increasing function of its own market size n.[12] This dependency stems from the increasing ability to influence the terms-of-trade in one's favor with increasing market size. From the equations above it is obvious that Home's optimal tariff will be lower, (higher) than Foreign's optimal tariff if $n < 1$, ($n > 1$). Note that so far each country's optimal tariff is independent of the opponent's tariff. Interaction between the tariff choices of both countries will now be established by means of a sequential game.

2.2 Trade Disputes as Sequential Games

Suppose now that there are two WTO members, and that these countries have committed themselves to an initial free trade agreement. That is, both τ and τ^* have to be equal to zero in order to fulfill the agreement. Under such a type of agreement, countries could be tempted to violate the agreement by a unilateral increase of the import tariff in order to benefit from an increase in their own welfare.[13]

Let Home be the first mover in this sequential game. Then Home will decide whether to violate the agreement, by raising its tariff above the allowed level, or to comply with the agreement. Foreign, being the second mover, observes the choice of the first mover. In case

[11] See Mathematical Appendix 6.1.

[12] Note that $\frac{\partial \tau_o[n]}{\partial n} = \frac{a}{4b(1+n)^2}$ is always positive.

[13] A typical WTO example for such a situation would be any WTO member's obligation to grant every trading partner an import tariff that is lower than or equal to its Most-Favored-Nation import tariff, while at the same time this particular member possibly would like to discriminate among its trading partners by setting different import tariffs.

the first mover violates the agreement, the second mover can choose between doing nothing and filing a complaint at costs c at the Dispute Settlement Body (DSB) in order to be entitled to retaliate against Home.[14]

Although the typical dispute settlement process consists of multiple stages, starting with a request for consultations, via the ruling of panel and appellate body, up to the request for the suspension of concessions, in this model it is reduced to a single decision of the second mover (to complain or not to complain).[15]

The DSU states that *"[t]he level of the suspension of concessions or other obligations authorized by the DSB shall be equivalent to the level of the nullification or the impairment."*[16]

While the exact method of calculating the level of nullification or impairment is left to the discretion of the ruling panel, legal practice is dominated by a counterfactual trade value approach.[17] The trade value approach simply compares price times quantity of the traded good before and after the implementation of the disputable trade measure. The difference between these two trade values is seen as the level of nullification or impairment suffered by the complainant. Or, in terms of the model at hand, the damage to the second mover.

The trade value of Home's import good $tv_x[\tau]$, is simply Home's import demand times the equilibrium world market price: $tv_x[\tau] := (D_x[\hat{p}_x[\tau] + \tau])\hat{p}_x[\tau]$. Consequently, the change in the trade value due to an increase in Home's import tariff is given by $\Delta tv_x[\tau] := (D_x[\hat{p}_x[\tau] + \tau])\hat{p}_x[\tau] - (D_x[\hat{p}_x[0] + 0])\hat{p}_x[0]$. In this model the expression becomes:

$$\Delta tv_x[\tau] = \frac{n\tau(-a(2+3n) + 2bn\tau)}{(2+n)^2} \tag{11}$$

The change in trade value of the foreign import good $\Delta tv_y[\tau^*]$ is obtained by similar means:

[14]Litigation costs can be thought of as incorporating the direct monetary costs of hiring a law firm or a consulting company in the course of the preparation of the complaint as well as the loss of political goodwill of the trading partner. Nordström (2005) emphasizes the role of direct monetary litigation costs and provides data on its composition.

[15]This simplification of the legal process is achieved by assuming (i) the presence of perfect information, (ii) perfect monitoring and (iii) absence of legal failure. While perfect monitoring means that a violation of the trade agreement will always be detected by the harmed victim, the absence of legal failure means that the panel judges every violation to be a violation.

[16]DSU Article 22, para 4.

[17]See Jordan (2005), pages 119-124 for a discussion of the employed calculation methods. The dominating method used in this paper was employed for example in the following cases: WT/DS26 EC-Hormones, WT/DS27 EC-Bananas, WT/DS160 US-Copyright.

$\Delta tv_y[\tau^*] := (D_y{}^*[\hat{p}_y[\tau^*] + \tau^*])\hat{p}_y[\tau^*] - (D_y{}^*[\hat{p}_y[0] + 0])\hat{p}_y[0]$, or:

$$\Delta tv_y[\tau^*] = \frac{1}{9}\tau^*(-5a + 2b\tau^*) \tag{12}$$

The equivalence condition cited above requires that the retaliatory distortion of the trade value has to be less than or equal to the distortion that was caused by the initial violation. This condition holds if $\Delta tv_y[\tau^*] \leq \Delta tv_x[\tau]$. Solving this expression for τ^* yields Foreign's maximum admissible tariff as a function of Home's tariff τ and the market size ratio n. Let this equivalence restriction on Foreign's retaliatory tariff be denoted by τ^*_{eq}:

$$\tau^*_{eq}[\tau, n] = \frac{5a(2+n) - \sqrt{25a^2(2+n)^2 - 72abn(2+3n)\tau_h + 144b^2n^2\tau^2}}{4b(2+n)} \tag{13}$$

The Dispute Settlement System's equivalence condition thus creates a strategic link between Home's violative tariff on imports of good x and Foreign's retaliatory tariff on imports of good y.

3 Strategic Behavior

Due to the assumption of perfect information the subgame perfect equilibrium strategies are found by backward induction, starting with Foreign as the second mover.

3.1 The Second Mover's Best Response

For a given violation of the initial free trade agreement (i.e. $\tau > 0$) Foreign has to make two decisions. First, how much to retaliate within the permitted interval $0 \leq \tau^*_r \leq \tau^*_{eq}$. Second, whether or not to file a complaint at costs c in order to be entitled to retaliate with a retaliatory tariff τ^*_r.

Earlier calculations have shown that Foreign would maximize its welfare by setting its optimal tariff $\tau^*_o = \frac{a}{8b}$ if it faced an unrestricted optimization problem.[18] However, if the equivalence condition restricts Foreign's retaliation to a level below τ^*_o, Foreign will completely

[18] Since Foreign's welfare is a continuous function of its import tariff τ^*, which is strictly increasing in the interval between zero and τ^*_o, it follows that Foreign's welfare-maximizing retaliatory tariff τ^*_r has an upper bound at its optimal tariff τ^*_o.

exploit the admissible retaliation tariff and set its retaliatory tariff τ_r^* equal to $\tau_{eq}^*[\tau, n]$. In short, Foreign's retaliatory tariff τ_r^* is given by:

$$\tau_r^*[\tau, n] = \min\{\tau_o^*, \tau_{eq}^*[\tau, n]\} \tag{14}$$

After having determined the extent of Foreign's retaliation, I will now analyze whether or not Foreign will retaliate at all.

Necessary Condition for Retaliation

Foreign will retaliate whenever the welfare gain from retaliation is higher than litigation costs (i.e. $\hat{w}^*[\tau, \tau_r^*[\tau, n], n] - \hat{w}^*[\tau, 0, n] > c$ has to hold). Since the maximum achievable welfare gain is realized when Foreign implements τ_o^* as its retaliatory tariff, it follows that litigation costs are prohibitively high if $c \geq \hat{w}^*[\tau, \tau_o^*, n] - \hat{w}^*[\tau, 0, n]$ holds. This condition states that litigation costs are prohibitive whenever welfare from complaining and retaliating is lower than welfare from doing nothing, even though the complainant is entitled to set its optimal tariff. The consequence of such prohibitively high litigation costs would be a breakdown of the strategic link between Home's and Foreign's actions.[19] Therefore, the remainder of the analysis focuses on the case of non-prohibitive costs, such that $c < c_p$ holds, where c_p stands for prohibitive costs.[20] Note that the prohibitive level of litigation costs is independent of market size in the current model. Since the market size of Foreign is normalized to one, c_p is a constant and it is possible to express litigation costs more conveniently as a fraction of prohibitive costs. Let $c := \gamma c_p$, then $\gamma = \frac{c}{c_p}$ displays present costs as a fraction of prohibitive costs. It follows that $\gamma < 1$ is a necessary condition for Foreign to retaliate.

Sufficient Condition for Retaliation

While Foreign's litigation costs are exogenously determined, the admissible level of Foreign's retaliatory tariff $\tau_{eq}^*[\tau, n]$ depends positively upon the market size ratio n and the level of Home's initial violation τ. In other words, the larger the offending country's market relative to the offended country's market and the more severe the offense, the higher will be the level

[19] Due to perfect information, Home anticipates that Foreign is not retaliating when costs are prohibitive. Therefore, Home would always play its optimal tariff while Foreign would never retaliate.

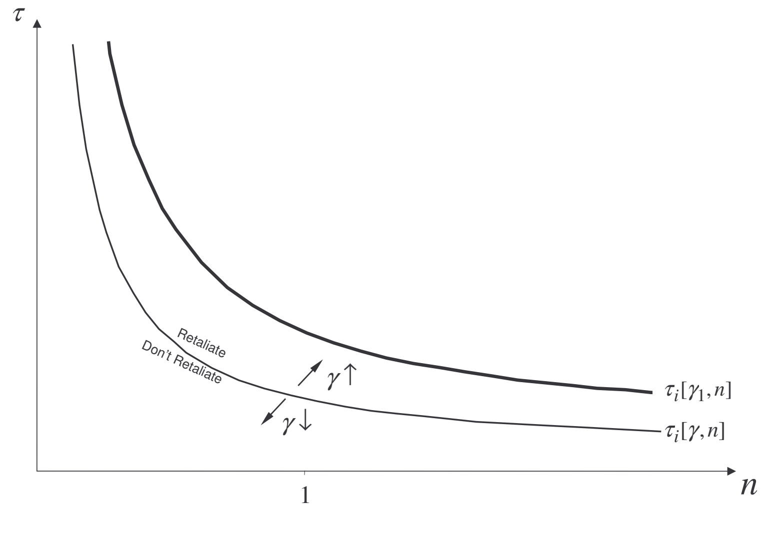
[20] In the model at hand c_p is given by $c_p = \frac{a^2}{144b}$.

of permitted retaliation according to the equivalence condition.[21] As a consequence, there will be a set of values of γ, n and τ that leads Foreign to be indifferent between retaliating and not retaliating. Since the model has tariffs as strategic instruments, it is convenient to express the locus of Foreign's indifference in terms of Home's tariff τ. Setting Foreign's welfare gain from retaliation equal to litigation costs ($c = \hat{w}^*[\tau, \tau_o^*, n] - \hat{w}^*[\tau, 0, n]$), one can solve for Home's tariff that leads Foreign to be indifferent between retaliating and not retaliating, as a function of γ and n. This indifference-inducing tariff of Home is denoted as $\tau_i[\gamma, n]$ in the following.

$$\tau_i[\gamma, n] = \frac{a(12 + 18n - \sqrt{18(4 + n(20 + 17n)) + 18(2 + n)^2\sqrt{1-\gamma} - (2 + n)^2\gamma})}{24bn}$$

Figure 1 displays two alternative indifference curves. The upper curve represents the case of prohibitive costs (let $\gamma_1 = 1$ and $\gamma_0 = 0$ denote the cases of prohibitive costs and zero costs respectively). The lower curve represents a case of $0 < \gamma < 1$. Thus, the n-τ-space can be

Figure 1:



separated into a Northeastern set of locations where Foreign will retaliate (i.e. $\tau > \tau_i[\gamma, n]$)

[21]Formally the benefit from retaliating is increasing in the market size of the offender ($\frac{\partial \hat{w}^*[\tau, \tau_r^*[\tau,n],n]}{\partial n} > 0$) and increasing in the severity of the offense ($\frac{\partial \hat{w}^*[\tau, \tau_r^*[\tau,n],n]}{\partial \tau} > 0$), for any given non-prohibitive level of litigation costs and as long as $\tau_{eq}^*[\tau, n] < \tau_o^*$ holds.

and a Southwestern set of locations, where Foreign will not retaliate (i.e. $\tau \leq \tau_i[\gamma, n]$).

The figure reveals that Foreign's retaliation threshold is lower, the lower the level of litigation costs. It also shows that n and τ are "substitutes" from the perspective of Foreign, who is eventually interested in the level of admissible retaliation. In other words, a Home country with a small market, raising its import tariff steeply, could cause the same Δtv_x (which translates into the admissible retaliation tariff) as a Home country with a large market which raises its import tariff only slightly.

As a summary, Foreign's best response $\hat{\tau}^*$ for non-prohibitive costs is given by:

$$\hat{\tau}^* = \begin{cases} 0, & \text{iff } \tau \leq \tau_i[\gamma, n] \\ \tau_r^*[n, \tau], & \text{iff } \tau > \tau_i[\gamma, n] \end{cases} \tag{15}$$

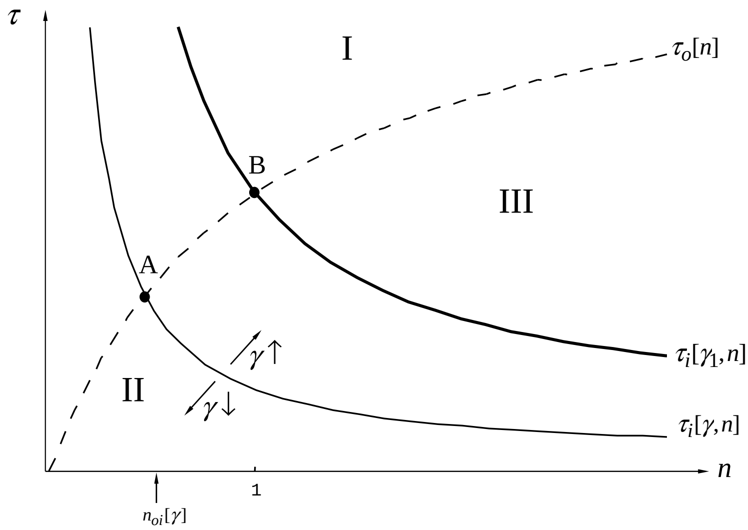
3.2 The First Mover's Best Response

Home sets its tariff, anticipating the consequences of doing so in terms of whether or not there will be any retaliation and in terms of the extent of a possible retaliation. Note that Home's welfare as a function of its import tariff τ is no longer a continuous function, not even for the set of non-prohibitive tariffs. Home's welfare will now have a step at the point where Foreign switches between retaliating and not retaliating due to an incremental increase in Home's offense. Therefore, one has to distinguish between two cases, depending on whether Foreign retaliates or not. In the following, offenses triggering retaliation (i.e. $\tau > \tau_i[\gamma, n]$) will be referred to as major offenses, while smaller levels of violation which do not trigger retaliation (i.e. $0 < \tau \leq \tau_i[\gamma, n]$) will be referred to as minor offenses. Consider Figure 2 where the bold indifference curve represents $\tau_i[\gamma, n]$ for prohibitive costs (i.e. γ_1), while the thin indifference curve represents $\gamma < 1$, and the dashed upward sloping curve depicts Home's optimal tariff. Three sets of dominated strategies can be ruled out right from the start.

Lemma 1 *Home never plays a tariff of* $\tau > \tau_o[n]$.

Clearly all combinations of τ and n located above Home's optimal tariff (Set I in Figure 2) can be excluded from further analysis for the simple reason that the choice of all these

Figure 2:



locations is strictly dominated by choosing $\tau_o[n]$.

Lemma 2 *Home never plays a tariff of* $\tau < \tau_o[n] \wedge \tau < \tau_i[\gamma, n]$.

For all tariffs located in Set II, Home could raise its tariff, thereby getting closer to its optimal tariff, without triggering retaliation since Foreign would only retaliate if the retaliation threshold was exceeded. Hence this set of tariffs is strictly dominated by $\tau_o[n]$ for $n \leq n_{oi}[\gamma]$ and by $\tau_i[\gamma, n]$ for $n > n_{oi}[\gamma]$, where $n_{oi}[\gamma]$ denotes value of n at the intersection of $\tau_o[n]$ and $\tau_i[\gamma, n]$.[22]

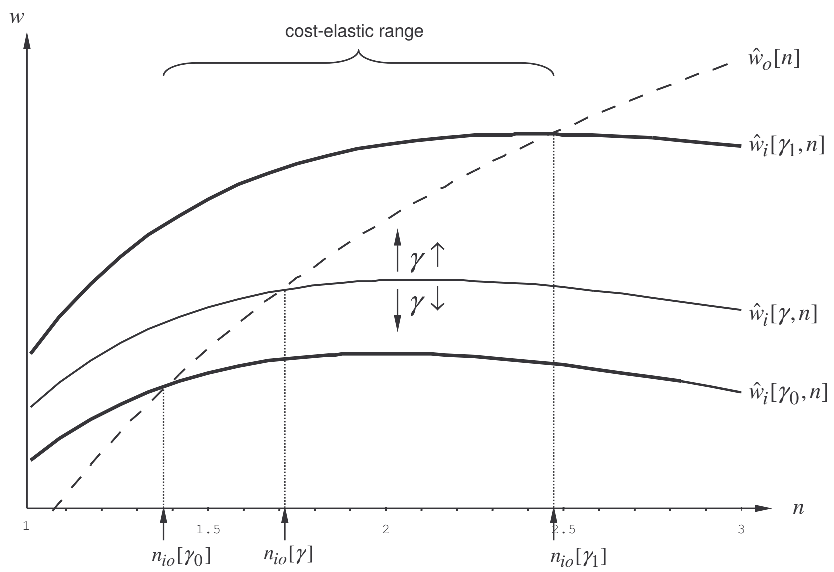
Lemma 3 *Home never plays a tariff of* $\tau_i[\gamma_1, n] \leq \tau < \tau_o[n]$.

Consider Set III and recall that $\tau_i[\gamma_1, n]$ is the set of n-τ-combinations that entitles Foreign to retaliate exactly with its optimal tariff $\tau_o^* = \frac{a}{8b}$. Hence, any n-τ-combination located above $\tau_i[\gamma_1, n]$ triggers the same amount of retaliation since Foreign's maximum retaliatory capacity is already exhausted. Therefore, all these n-τ-combinations are strictly dominated by playing $\tau_o[n]$.

[22]The subscript "oi" should remind the reader of the fact that n_{oi} denotes the critical market size where Home switches from playing $\tau_o[n]$ to playing $\tau_i[\gamma, n]$. The existence and the properties of this lower switching point $n_{oi}[\gamma]$ are examined in the Mathematical Appendix 6.3.

Home's remaining options are (i) to play its optimal tariff $\tau_o[n]$, yielding welfare of $\hat{w}_o[n] := \hat{w}[\tau_o[n], \tau_o^*, n]$, (ii) to play the current retaliation threshold $\tau_i[\gamma, n]$, yielding welfare of $\hat{w}_i[\gamma, n] := \hat{w}[\tau_i[\gamma, n], 0, n]$ and (iii) to play a tariff $\tau_{ma}[n]$ which maximizes Home's welfare given that Foreign retaliates elastically (which can only occur iff $\tau_i[\gamma, n] < \tau < \tau_i[\gamma_1, n]$), yielding welfare of $\hat{w}_{ma}[n] := \hat{w}[\tau_{ma}[n], \tau_{eq}^*[\tau_{ma}[n], n], n]$.[23] It is possible to show that option (iii) will only be considered by Home for an extremely narrow set of n-γ-combinations. A necessary condition for playing $\tau_{ma}[n]$ is $\gamma \leq 0.03086$ and $1 < n \leq 1.40231$. Since the tariff level $\tau_{ma}[n]$ as well as the associated welfare level $\hat{w}_{ma}[n]$ are extremely close to $\tau_i[\gamma, n]$ and $\hat{w}_i[\gamma, n]$ in this particular region, further analysis of this option will be omitted.[24] Home's

Figure 3:



welfare under the two relevant strategies is depicted in Figure 3. The dashed curve represents $\hat{w}_o[n]$, which is Home's welfare when both Home and Foreign play their optimal tariffs. The three continuous curves represent $\hat{w}_i[\gamma, n]$ for different cost-levels. The upper bold continuous curve is associated with prohibitive costs (i.e. γ_1). The lower bold continuous curve

[23]The subscript ma should remind the reader of the fact that this tariff is associated with a major offense. See Mathematical Appendix 6.2 for derivation and properties of $\tau_{ma}[n]$.

[24]Formally, one could rule out $\tau_{ma}[n]$ by assuming $\gamma > 0.03086$. See Mathematical Appendix 6.5.

is associated with zero costs (i.e. $\gamma_0 = 0$), while the finer continuous curve in the middle represents intermediate costs of $0 < \gamma < 1$.[25] $n_{io}[\gamma]$ denotes the value of n where $\hat{w}_i[\gamma, n]$ crosses $\hat{w}_o[n]$ from above.[26] In other words, $n_{io}[\gamma]$ is the critical country size where Home switches from committing a minor offense to committing a major offense.

Since the case of no costs (γ_0) and the case of prohibitive costs (γ_1) constitute natural boundaries to the shifting range of $\hat{w}_i[\gamma, n]$, Figure 3 already reveals that Home's choice between the two strategies is completely independent of litigation costs for some "exterior" values of n, while it depends upon them for some "interior" values of n. Hence the following proposition distinguishes between three areas of n.

Proposition 1

(i) For all $n \leq 1.38504$*, Home commits a minor offense.*

(ii) For all $n > 2.46187$*, Home commits a major offense.*

(iii) For all $1.38504 < n \leq 2.46187$*, Home's decision between a major and a minor offense is dependent upon the level of litigation costs. Paradoxically, high litigation costs lead to a minor offense, while low litigation costs lead to a major offense.*

Proof: See Mathematical Appendix 6.6.

To understand the intuition for the first part of Proposition 1, consider Lemma 1 and Lemma 2 which state that the smallest countries (i.e. $n \leq n_{oi}[\gamma]$) can play their optimal tariff without harming their trading partners enough to trigger a complaint. Moreover, countries of size $n_{oi}[\gamma] < n \leq 1.38504$ prefer to restrict their tariff to $\tau_i[\gamma, n]$ in order not to trigger retaliation since $\hat{w}_o[n] < \hat{w}_i[\gamma, n]$ holds in this interval of n.

The second part of Proposition 1 basically states that very large Home countries which exceed a particular size, find it more beneficial to commit a major offense by playing $\tau_o[n]$ and taking Foreign's retaliation into account, than to restrict their offense to the maximum tolerated offense level of $\tau_i[\gamma, n]$. This result follows from the finding that $\hat{w}_o[n] > \hat{w}_i[\gamma, n]$ holds in this interval of n.

[25]Note that costs are a shift parameter of $\hat{w}_i[\gamma, n]$, while $\hat{w}_o[n]$ is independent of costs.

[26]The subscript "io" should remind the reader of the fact that n_{io} denotes the critical country size where Home switches from playing $\tau_i[\gamma, n]$ to playing $\tau_o[n]$.

The third part of Proposition 1 refers to Home countries whose n lies between the two just described boundaries. In this interval of n, the location of the switching point $n_{io}[\gamma]$ is dependent upon the pertinent level of litigation costs. Figure 3 shows that $n_{io}[\gamma]$ lies the more to the left (right) of the bounded interval, the lower (higher) litigation costs are. This means that lowering litigation costs will lead even smaller countries than before to committing a major offense, while increasing litigation costs will deter even larger countries than before from committing a major offense. The economic reason for this behavior can be explained by considering the right hand side of Figure 2 (i.e. $n > 1$) again. Note that the gap between $\tau_i[\gamma, n]$ and $\tau_o[n]$ widens with increasing market size. This means that the opportunity cost of playing the threshold tariff $\tau_i[\gamma, n]$ is increasing in n since $\tau_i[\gamma, n]$ is decreasing in n while $\tau_o[n]$ is increasing in n.[27] Consequently, there is a switching point in terms of n where Home's opportunity costs of avoiding retaliation will equal Home's costs from taking retaliation into account. At this point Home will switch from playing $\tau_i[\gamma, n]$ to playing $\tau_o[n]$

To summarize, Home's best response $\hat{\tau}$ is given by:

$$\hat{\tau} = \begin{cases} \tau_o[n], & \text{if } n \leq n_{oi}[\gamma] \\ \tau_i[\gamma, n], & \text{iff } n_{oi}[\gamma] < n \leq n_{io}[\gamma] \\ \tau_o[n], & \text{if } n > n_{io}[\gamma] \end{cases} \tag{16}$$

Stated verbally:

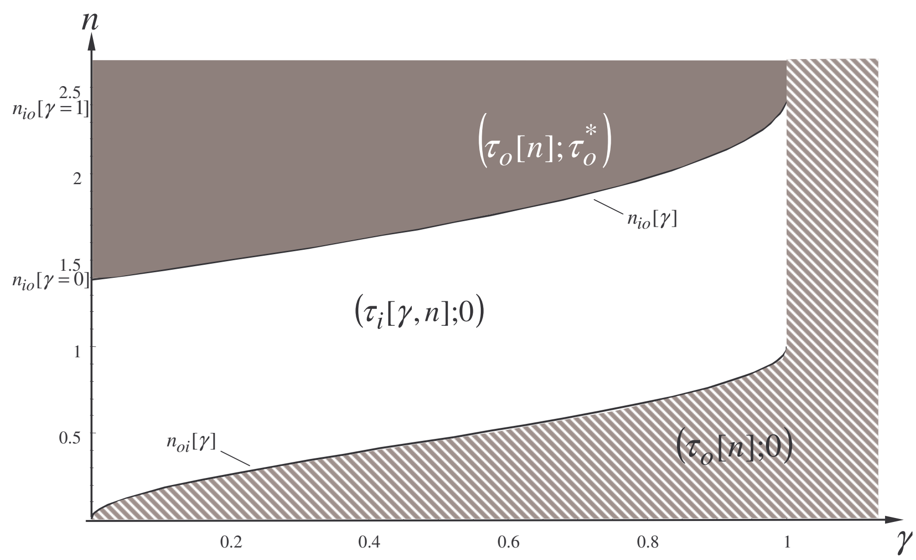
1. The smallest Home countries will play their optimal tariff because they do not cause enough damage to trigger retaliation.
2. Home countries of intermediate market size will restrict their tariff to a level below their optimal tariff in order to avoid retaliation by bothering Foreign no more than the latter's tolerance level.
3. The biggest Home countries will play their optimal tariffs and take Foreign's retaliation into account.

[27] For $\hat{w}_o[n]$, it can be shown that $\frac{\partial \hat{w}_o[n]}{\partial n} > 0$ and $\frac{\partial^2 \hat{w}_o[n]}{\partial^2 n} < 0$. See Mathematical Appendix 6.4.

3.3 Equilibria

Both Home's and Foreign's best response functions are conditional on n and the level of litigation costs. Therefore the pair of subgame perfect Nash equilibrium strategies $(\hat{\tau};\hat{\tau}^*)$ is as well dependent upon the exogenously determined levels of γ and n. Figure 4 shows that the γ-n-space is divided into three areas of different equilibria. The grey area in the

Figure 4:



Northwest of Figure 4 represents a trade war between the two countries, where each country is playing its optimal tariff. This type of equilibrium occurs if Home is large enough to put up with Foreign's retaliation. It is bordered below by $n_{io}[\gamma]$.

The white area in the center of Figure 4 represents the equilibria, in which one country bothers the other country just so much that retaliation is avoided. The economic intuition for the existence of this type of equilibrium is that either Home countries are too small to be willing to put up with retaliation, or Home's opportunity costs of a minor offense[28] are relatively low, which is the case if litigation costs are relatively high. This type of equilibrium is bordered above by $n_{io}[\gamma]$ and below by $n_{oi}[\gamma]$. Note that both afore-mentioned types of

[28]The opportunity costs of a minor offense are Home's forgone benefits from a tariff increase to $\tau_o[n]$.

equilibria only exist for non-prohibitive costs. The striped area, which stretches at the bottom and along the right edge of Figure 4 represents the set of equilibria where Home plays its optimal tariff, while Foreign does not retaliate. This type of equilibrium occurs if either Home's market is so small that Foreign is not harmed enough in order to be willing to pay litigation costs (the cases at the bottom) or costs are prohibitive (the cases at the right edge where $\gamma \geq 1$ holds).

3.4 Comparative Statics in Litigation Costs

After having computed the Nash equilibrium tariff pairs as functions of country size and litigation costs, it is possible to finally analyze the effects of a reduction of litigation costs by consulting Figure 4 again. It is useful to distinguish between a cost reduction that passes the threshold of prohibitive costs on the one hand and a cost reduction that occurs within the range of non-prohibitive costs on the other hand.

3.4.1 Prohibitive Initial Costs

Consider the case where initial litigation costs are prohibitive (i.e. $\gamma \geq 1$). Then the initial equilibrium tariff pair is given by $(\tau_o[n]; 0)$, with the Home playing its optimal tariff and Foreign not retaliating at all. The effects of a reduction of litigation costs to a level just an increment below the prohibitive threshold of $\gamma = 1$ are dependent upon the pertinent level of n.

The tariff of a large Home country with $n > n_{io}[\gamma]$ is left unchanged, although Foreign implements retaliation of τ_o^*.

In the case of an intermediate size Home country with $n_{oi}[\gamma] < n \leq n_{io}[\gamma]$ compliance is improved since the post reduction tariff pair is $(\tau_i[\gamma, n]; 0)$.

In the case of a small Home country with $n \leq n_{oi}[\gamma]$ both countries' tariffs and welfare levels are left unchanged.

3.4.2 Non-prohibitive Initial Costs

Now consider the case where initial non-prohibitive litigation costs (i.e. $\gamma < 1$) are further reduced.

For high values of n, where the initial set of equilibrium tariffs is $(\tau_o[n]; \tau_o^*)$, a reduction of litigation costs will have no effect at all, and the equilibrium does not change.

Suppose the initial equilibrium set of tariffs was $(\tau_i[\gamma, n]; 0)$, which corresponds to any location inside the white area in the center of Figure 4. In this case the effects depend even further on n. If $n \leq n_{io}[\gamma_0]$,[29] the reduction in litigation costs does not change the equilibrium strategies as such since the post reduction equilibrium strategies are again $(\tau_i[\gamma, n]; 0)$. Nevertheless, Home will set a lower tariff because the absolute level of $\tau_i[\gamma, n]$ has been reduced in the course of the cost reduction. However, if $n > n_{io}[\gamma_0]$,[30] the cost reduction may change the equilibrium, such that Home commits a more severe offense by switching to its optimal tariff $\tau_o[n]$ thereby triggering retaliation of Foreign, who switches to its own optimal tariff τ_o^*. The finding that a reduction of litigation costs may lead to more severe offenses, although the cost reduction succeeds in rendering retaliation more attractive, might seem paradoxical at first sight, but it becomes clear upon closer investigation.[31] Note that this paradoxical effect only occurs for offenders with markets of larger size than the ones of their victims (i.e. $n_{io}[\gamma_0] = 1.38504 < n \leq 2.46187 = n_{io}[\gamma_1]$).

Suppose the initial equilibrium set of tariffs was $(\tau_o[n]; 0)$, which corresponds to the striped area at the bottom of Figure 4. In this case a reduction of costs unambiguously improves the compliance of Home, who switches from playing $\tau_o[n]$ to playing $\tau_i[\gamma, n]$, while Foreign's tariff remains at zero. Thus, the reduction of litigation costs may succeed in forcing countries into compliance by rendering retaliation more attractive. Note that this intuitive effect only occurs for offenders being smaller than their victims (i.e. $n \leq 1$).

[29] Recall that $n_{io}[\gamma_0]$ is equal to 1.38504 and therefore independent of any values of parameters and variables.

[30] See preceding footnote.

[31] The reduction of litigation costs initially affects Foreign's decision by lowering the tolerated level of violation (i.e. lowering $\tau_i[\gamma, n]$). Consequently, Home's opportunity costs of a minor offense increase since the gap between its optimal tariff $\tau_o[n]$ and the retaliation threshold widens. At some point the welfare gain, which is associated with this tariff gap, exceeds the welfare loss that would arise in the course of provoked retaliation. If litigation costs are reduced below that point, Home will switch from committing a minor offense to committing a major offense.

4 Extension

4.1 Rationale and Model Adaptations

In order to analyze if the results of the first model are robust to variations, this subsection models the asymmetry of the two countries in a different way, while the structure of the analysis remains unchanged. Throughout this section the emphasis is put on highlighting the crucial differences that result from the changed specifications.

Suppose the representative consumers' quasilinear utility functions were identical in both countries.[32] Suppose further that Foreign has one consumer while Home has n identical consumers. Consequently, demand at Home is now n times foreign demand in both sectors. Demand at Home is then given by:

$$D_x[p_x] := (a - bp_x)n \tag{17}$$

$$D_y[p_y] := (a - bp_y)n \tag{18}$$

Foreign's demand is given by:

$$D_x^*[p_x] := a - bp_x \tag{19}$$

$$D_y^*[p_y] := a - bp_y \tag{20}$$

Again Foreign supplies only good x while Home supplies only good y.

$$S_x^*[p_x] := bp_x \tag{21}$$

$$S_y[p_y] := bp_y \tag{22}$$

Equilibrium prices, quantities, welfare levels and optimal tariffs are obtained in an analogous manner to the calculations conducted in the first model. However, unlike before, Foreign's optimal tariff $\tau_o^*[n]$ has become a function of n. It is given by: $\tau_o^*[n] = \frac{a}{b(3+4n+n^2)}$. Note that Foreign's optimal tariff now clearly decreases in n, since Foreign's ability to influence

[32]Let utility for a representative consumer be given by: $U[x,y,z] = U^*[x,y,z] = z + (ax - \frac{x^2}{2})\frac{1}{b} + (ay - \frac{y^2}{2})\frac{1}{b}$. Again trade is balanced via the numeraire good z.

world market prices and hence its ability to generate terms of trade gains deteriorates with increasing n.

The rules of the tariff setting game and the modeling of the WTO's Equivalence Condition remain unchanged.

4.2 The Second Mover's Best Response

Again Foreign's welfare is a continuous function of its import tariff τ^*, which is positive and strictly increasing in the interval between zero and $\tau_o^*[n]$ for $n < \infty$. Thus, Foreign's retaliatory tariff τ_r^* is given by $\tau_r^*[\tau, n] = \min\{\tau_o^*[n], \tau_{eq}^*[\tau, n]\}$.

Necessary Condition for Retaliation

Litigation costs c are prohibitive if $c \geq \hat{w}^*[\tau, \tau_o^*[n], n] - \hat{w}^*[\tau, 0, n]$ is satisfied. Substituting explicit values for $\hat{w}^*[\tau, \tau_o^*[n], n]$ and $\hat{w}_y^*[\tau, 0, n]$ yields prohibitive costs c_p as a function of n:

$$c_p[n_p] = \frac{a^2}{2b(2+n_p)^2(3+4n_p+n_p^2)} \tag{23}$$

The subscript p is appended to the country size parameter n in order to be able to identify the cases where costs are prohibitive in terms of country size.[33] Equation 23 reveals that an increase in litigation costs leads to a decrease of the threshold where costs have a prohibitive effect in terms of country size (i.e. $\frac{\partial c_p[n_p]}{\partial n_p} < 0$). Since $c_p[n_p]$ is a continuous and monotonically decreasing function, it holds that $n < n_p$ is a necessary condition for retaliation.[34]

Sufficient Condition for Retaliation

Foreign will only retaliate if the welfare gain associated with the implementation of its retaliatory tariff $\tau_r^*[\tau, n]$ exceeds litigation costs. Thus there will be a set of combinations of τ, n and n_p which leads Foreign to be indifferent between retaliating and not retaliating.

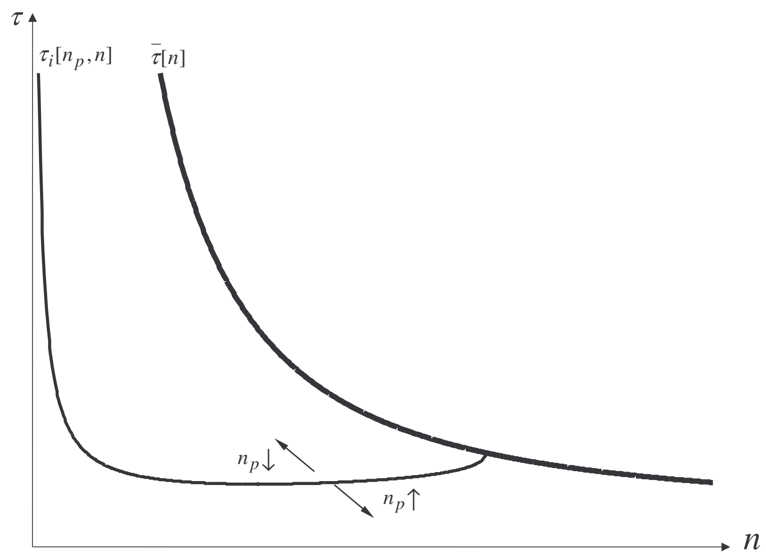
[33] If e.g. $n_p = 2$ Foreign would not complain against offenses committed by countries of size $n \geq 2$, no matter how severe the offenses may be.

[34] For $c_p[n_p]$ the following properties can be shown to hold:

$$c_p[n_p] \begin{cases} < c_p[n], & \text{iff } n_p > n \\ = c_p[n], & \text{iff } n_p = n \\ > c_p[n], & \text{iff } n_p < n \end{cases}$$

The set of these indifference inducing combinations can be found in terms of Home's tariff τ. The resulting tariff $\tau_i[n_p, n]$ is again a function of costs (already expressed in terms of the prohibitive country size ratio n_p) and country size. Figure 5 illustrates that the thin

Figure 5:



hook-shaped $\tau_i[n_p, n]$-curve only runs up to the level of n where n equals n_p, since $\tau_i[n_p, n]$ obviously does not exist for prohibitive costs (i.e. $n \geq n_p$). This indifference curve separates the n-τ-space into two different strategic sections. Combinations of τ and n lying to the Southwest (i.e. low τ and low n) or to the East (i.e. $n \geq n_p$) of the curve will not trigger foreign retaliation, whereas combinations of τ and n lying above the curve will trigger foreign retaliation.

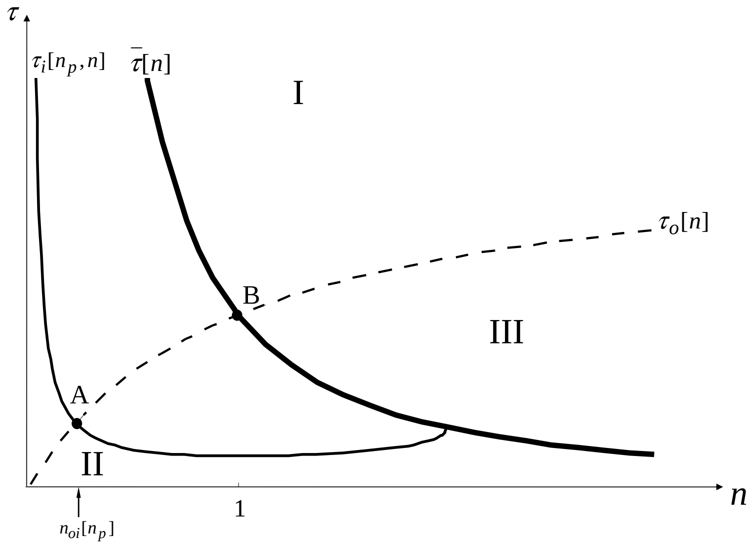
The bold downward sloping curve labeled $\overline{\tau}[n]$ represents all combinations in the n-τ-space where the permitted retaliatory tariff $\tau^*_{eq}[\tau, n]$ equals Foreign's optimal tariff $\tau^*_o[n]$.[35] Economically this means that Foreign's retaliation is inelastic in Home's initial violation for combinations of n and τ that lie above the $\overline{\tau}[n]$-curve, since Foreign will never retaliate with a tariff that is higher than its optimal tariff.

[35] Analytically $\overline{\tau}[n]$ is found by setting $\tau^*_{eq}[\tau, n]$ equal to $\tau^*_o[n]$ and solving for τ.

4.3 The First Mover's Best Response

The perfectly informed Home country decides between committing a minor offense (i.e. $\tau \leq \tau_i[n_p, n]$), which does not trigger retaliation, and a major offense (i.e. $\tau > \tau_i[n_p, n]$), which does trigger retaliation.[36] Lemma 1, Lemma 2 and Lemma 3 can be shown to hold

Figure 6:



analogously in this model specification. Consequently the sets labeled I, II and III in Figure 6 constitute strictly dominated strategies for the same reasons as in the previous model.

Once more Home's remaining options are (i) to play its optimal tariff $\tau_o[n]$, (ii) to play the retaliation threshold tariff $\tau_i[n_p, n]$ and (iii) to play a tariff $\tau_{ma}[n]$, which maximizes Home's welfare, given that Foreign retaliates elastically. Again the third option will be dominated by playing one of the other two tariffs except for the occurrence of a very narrow range of country size ratios and costs. Consequently further analysis of this option is omitted for the same reasons as in the previous model. For the sake of completeness it can be shown that the Home will only play $\tau_{ma}[n]$ if costs are extremely low (i.e. $n_p \geq 3.7480$) and if $1 < n \leq 1.2128$.

[36]Note that now $\tau_i[n_p, n]$ does not exist for $n > n_p$, since costs are prohibitive in these cases. Therefore it seems reasonable to count as well those violative tariffs as major offenses, where Home plays its optimal tariff because costs are prohibitive.

The critical country size ratio $n_{io}[n_p]$ where Home switches from committing a minor offense to committing a major offense can be derived along the lines of the calculations in the previous model.[37]

Proposition 2

(i) *For all* $n \leq 1.21280$, *Home commits a minor offense.*

(ii) *For all* $n > 1.60254$, *Home commits a major offense.*

(iii) *For all* $1.21280 < n \leq 1.60254$, *Home's decision between a major and a minor offense is dependent upon the level of litigation costs. Paradoxically, high litigation costs lead to a minor offense, while low litigation costs lead to a major offense.*

Proof: See Mathematical Appendix 6.7.

The paradoxical result that a reduction of litigation costs may lead even smaller countries than before to committing a major offense holds as well in this model. Just like before the shifting range of $n_{io}[n_p]$ has a boundary above (at $n = 1.60254$) and below (at $n = 1.21280$) at absolute levels of country size, while it is cost-elastic only between these boundaries. Consequently, countries of size $n \leq 1.21280$ will never play $\tau_o[n]$, countries of size $n > 1.60254$ will always play $\tau_o[n]$, while countries of size $1.21280 < n \leq 1.60254$ will play either $\tau_o[n]$ or $\tau_i[n_p, n]$ depending upon the pertinent level of litigation costs.

4.4 Equilibria

Figure 7 shows the occurrence of three different subgame perfect Nash equilibrium strategy pairs $(\hat{\tau}; \hat{\tau}^*)$ in the n_p-n-space.[38] The diagonal line starting at the origin, has a slope of one. It divides the n_p-n-space into one upper triangular shaped set, where $n > n_p$ holds and one lower triangular shaped set, where $n < n_p$ holds. Clearly all n_p-n-combinations in the upper

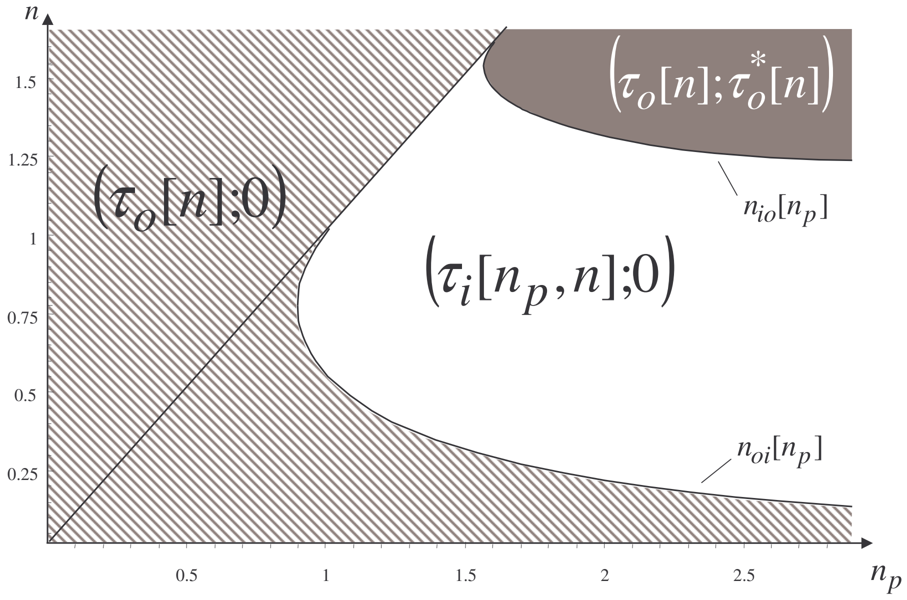
[37] Again the switching points between the three sections of Home's best response function are obtained by substituting Home's possible offensive tariffs and Foreign's associated retaliatory tariffs pairwise into Home's welfare function. The two resulting welfare functions of Home are given by:

1. $\hat{w}_o[n] = \hat{w}[\tau_o[n], \tau_o^*[n], n]$ and
2. $\hat{w}_i[n_p, n] = \hat{w}[\tau_i[n_p, n], 0, n]$.

These welfare functions are set equal to each other and solved for n in order to obtain the switching point $n_{io}[n_p]$.

[38] Recall that a high (low) level of n_p corresponds to a low (high) level of litigation costs.

Figure 7:



set exhibit prohibitive costs, such that the equilibrium in the upper triangular is given by $(\tau_o[n]; 0)$. This tariff pair constitutes as well an equilibrium in the striped area lying below the 45-degree line and below the $n_{oi}[n_p]$-curve. Although costs are not prohibitive in this area, the offense and therefore the permitted level of retaliation is not large enough to let Foreign break even with litigation costs.

The white area represents all combinations of n_p and n leading to an equilibrium tariff pair of $(\tau_i[n_p, n]; 0)$. This area is bordered below by $n_{oi}[n_p]$, above by $n_{io}[n_p]$ and to the left by the condition of non-prohibitive costs (i.e. the 45-degree line).

The upper grey area represents a trade war equilibrium with both countries playing their optimal tariffs. It is bordered below by $n_{io}[n_p]$ and to the left by the condition of non-prohibitive costs.

4.5 Comparative Statics in Litigation Costs

Again one has to distinguish between a cost reduction that passes the threshold of prohibitive costs and a cost reduction that occurs within the set of non-prohibitive costs.

4.5.1 Prohibitive Initial Costs

Consider the case where litigation costs are reduced from an initially prohibitive level (i.e. $n \geq n_p$) to a level lying an increment below this threshold. Then, similar to the findings of the first model, the consequences of the cost reduction depend upon the country size ratio. For large values of n the cost reduction triggers a trade war (i.e. $(\tau_o[n]; \tau_o^*[n])$). For intermediate values of n the cost reduction improves compliance (i.e. $(\tau_i[n_p, n]; 0)$), and for low values of n the post reduction tariff pair coincides with the initial tariff pair (i.e. $(\tau_o[n]; 0)$).

4.5.2 Non-prohibitive Initial Costs

Now consider the case where initial non-prohibitive litigation costs (i.e. $n < n_p$) are further reduced.

For high values of n, where the initial equilibrium is a trade war (i.e. $(\tau_o[n]; \tau_o^*[n])$), the cost reduction has no effect and the initial equilibrium does not change.

For intermediate values of n, where the initial equilibrium is $(\tau_i[n_p, n]; 0)$, the effects of a reduction of litigation costs depend even further on the country size ratio. If $n \leq 1.2128$, the cost reduction does not change the equilibrium strategy. If $n > 1.2128$, a cost reduction may change the equilibrium in a paradoxical way, just like in the basic model.

Finally, if the initial set of tariffs is $(\tau_o[n]; 0)$, which corresponds to the striped area to the right of the 45-degree line, a cost reduction improves the compliance of Home, who switches from playing $\tau_o[n]$ to playing $\tau_i[n_p, n]$, while Foreign's tariff remains at zero.

5 Conclusion

The outcomes of both models suggest that the DSS is unable to level out existing power imbalances between countries and therefore does not provide equality before the law. This finding is based on the fact that a country's ability to enforce a trade agreement under the rules of the DSS depends crucially upon the country's retaliatory capacity, which in turn is country specific. Moreover, litigation costs have been found to be a key determinant of a violated country's decision whether or not to file a complaint. Since several DSS experts argue that litigation costs are supposed to be higher for developing countries than for developed countries, the former may face not only a disadvantage in terms of retaliatory capacity but as well in terms of absolute litigation costs.[39]

The results have been employed to analyze the effects of a reduction of litigation costs. The findings suggest that a reduction of litigation costs succeeds in improving smaller countries' compliance, while it entices larger countries to commit more severe offenses.[40] Thus, a subsidization of litigation costs is supposed to make smaller countries even worse off than before, while large countries would enjoy a better protection of their trade interests against smaller countries.

Besides, a reduction of litigation costs is supposed to lead to more trade disputes surfacing in the dispute settlement record and cause an increase in the implementation of retaliation at the same time.

Another result of the model is related to the question whether or not the usage of the dispute settlement system is biased. The model predicts that a country is more likely to file a complaint if it (i) has a relatively high retaliatory capacity, (ii) faces low litigation costs and (iii) suffers from an offense at a relatively high level. While these theoretical findings may explain the dominance of rich countries in the dispute settlement record, they mean at the same time that the observable sample of reported disputes is biased in favor of countries with these particular characteristics. Therefore, the finding of Horn et al. (1999), which suggests that disputes occur randomly and reasonably proportional to the number of a country's product-market-pairings, may still be correct. However, in the light of the model at hand, the number of a country's product-market-pairings should no longer be seen as the central reason for the occurrence of a dispute, but rather as a side effect, that may be positively correlated with the real drivers of offenses and complaints which are a country's retaliatory capacity, litigation costs and the intensity of violation. Hence the theory suggests that the observable sample of disputes does not reflect the country-specific characteristics of the unobservable population of disputes. Therefore the unreported offenses (i.e. the

[39] See Bown (2005) and Nordström (2005). One reason for their finding is the fact that many developed countries have already sunk their litigation costs by running a permanent mission at Geneva, while developing countries face variable costs since they would have to hire law firms and consulting firms in order to prepare a complaint. Another reason may be the developing countries' fear of a loss of political goodwill, which could as well be seen as a component of litigation costs.

[40] This result parallels findings of the Economics of Crime literature. See for example Becker (1968), who shows that a reduction in litigation costs may lead some offenders to switch to more severe offenses, while it may reduce the offensive level of others.

dark figure of offenses) should contain a disproportionately large share of countries lacking retaliatory capacity, facing high litigation costs and being offended against at lower intensity. This typically applies for developing countries.

Finally, the model seems to provide a theoretical foundation for some existing empirical studies. The model's predictions agree with the empirical findings of Bown (2005), who concludes on page 16: *"Our formal evidence indicates that, despite market access interests in a dispute, an exporting country is less likely to participate in WTO litigation if it has inadequate power for trade retaliation, if it is poor and does not have the capacity to absorb substantial legal costs, if it is particularly reliant on the respondent country for bilateral assistance, or is engaged with the respondent in a preferential trade agreement. These are characteristics typically associated with developing countries in the WTO membership."* The empirical study of Guzman and Simmons (2005) supports the results as well. On page 591 they find that *"...developing countries are using the DSU in a way that reflects their current incapacity to launch effective legal cases against potential trade law violators."*.

6 Mathematical Appendix

6.1 Properties of the Aggregated Welfare Functions

To show that a country's welfare is concave in its own tariff it has to hold that:

(i)

$$\frac{\partial \hat{w}[\tau,\tau^*,n]}{\partial \tau} > 0 \Leftrightarrow \frac{n(an-4b(1+n)\tau)}{(2+n)^2} > 0$$

This condition is satisfied if the numerator is positive (i.e. if $n(an-4b(1+n)\tau) > 0$ holds). Solving this expression for τ yields $\tau < \frac{an}{4b+4bn}$, which is again Home's optimal tariff τ_o.

(ii)

$$\frac{\partial^2 \hat{w}[\tau,\tau^*,n]}{\partial^2 \tau} < 0 \Leftrightarrow -\frac{4bn(1+n)}{(2+n)^2} < 0$$

This condition is always satisfied.

A country's welfare is decreasing in the other country's tariff if it holds that:

$$\frac{\partial \hat{w}[\tau,\tau^*,n]}{\partial \tau^*} < 0 \Leftrightarrow \frac{2b\tau^*-a}{9} < 0$$

This condition is satisfied if it holds that $\tau^* < \frac{a}{2b}$, where $\frac{a}{2b}$ is the prohibitive level of τ^*, meaning that the traded amount of good y would equal zero under such a high tariff.

6.2 Properties of $\tau_{ma}[n]$

Aggregated welfare at Home in case of a major offense is given by:

$$\hat{w}[\tau,n] = \hat{w}[\tau, min\{\tau^*_{eq}[\tau,n], \tau^*_o\}, n]$$

For the cases where permitted retaliation has already reached τ^*_o, the maximization of $\hat{w}[\tau,n]$ yields again Home's optimal tariff $\tau_o[n]$ since τ^*_o is independent of τ. Therefore the optimal tariff remains unchanged, while welfare at Home is reduced by a fixed amount.

For the case of flexible retaliation (i.e. $\tau^*_{eq}[\tau,n] \leq \tau^*_o$) Home's welfare from a major offense is:

$$\hat{w}[\tau, n] = \frac{a^2(140 + 176n + 35n^2)}{72b(2+n)^2} - \frac{72b^2 n(2+n)\tau^2 - 3a(2+n)(12bn\tau + \sqrt{25a^2(2+n)^2 - 72abn(2+3n)\tau + 144b^2n^2\tau^2})}{72b(2+n)^2}$$

Taking the first derivative of $\hat{w}[\tau, n]$ w.r.t. τ yields:

$$\frac{\partial \hat{w}[\tau, n]}{\partial \tau} = \frac{3an(a(2+3n) - 4bn\tau)}{2(2+n)\sqrt{25a^2(2+n)^2 - 72abn(2+3n)\tau + 144b^2n^2\tau^2}} - \frac{n(a+4b\tau)\sqrt{25a^2(2+n)^2 - 72abn(2+3n)\tau + 144b^2n^2\tau^2}}{2(2+n)\sqrt{25a^2(2+n)^2 - 72abn(2+3n)\tau + 144b^2n^2\tau^2}}$$

Setting this expression equal to zero and solving for τ yields a polynomial of degree eight in n. After having applied a Taylor Series expansion of degree four around the value $n = 1$, the approximation of $\tau_{ma}[n]$ is given by $\tau_{ma}[n] = \frac{a}{b}\left(\frac{(n-1)}{15} - \frac{17(n-1)^2}{1125} + \frac{817(n-1)^3}{84375} - \frac{1679(n-1)^4}{421875}\right)$ The positive real roots of the polynomial are $n_1 = 1$ and $n_2 = 4.01578$. Obviously it holds that $\tau_{ma}[n] = 0$ at $n = 1$.

$\frac{\partial \tau_{ma}[n]}{\partial n}$ is positive at $n_1 = 1$ and negative at $n_2 = 4.01578$. This means that $\tau_{ma}[n]$ is crossing the zero line from below at $n_1 = 1$ and from above at $n_2 = 4.01578$. Hence $\tau_{ma}[n]$ must be positive between unity and n_2 and negative for values of n which are either smaller than unity or larger than n_2.

6.3 Properties of the lower switching point $n_{oi}[\gamma]$

$n_{oi}[\gamma]$ is the country size ratio where the first mover switches from playing $\tau_o[n]$ to playing $\tau_i[\gamma, n]$. It is found by setting them equal to each other and solving for n. The polynomial has only one positive real root. It takes on the value 1 for $\gamma = 1$ and the value 0 for $\gamma = 0$. The local Taylor approximation of $n_{oi}[\gamma]$ at a particular value of γ, with $0 < \gamma < 1$, is strictly increasing in γ. In other words, locally ($0 < n < 1$, $0 < \gamma < 1$) it holds that $\frac{\partial n_{oi}[\gamma]}{\partial \gamma} > 0$.

6.4 Properties of $\hat{w}_o[n]$

Substituting Home's optimal tariff into its welfare function yields:

$$\hat{w}_o[n] := \hat{w}[\tau_o[n], \tau_o^*, n]$$

In explicit terms the function reads:

$$\hat{w}_o[n] = \frac{a^2(17 + 25n)}{64b(1 + n)}$$

The first and second derivatives w.r.t. n are given by:

$$\frac{\partial \hat{w}_o[n]}{\partial n} = \frac{a^2}{8b(1 + n)^2}, \qquad \frac{\partial^2 \hat{w}_o[n]}{\partial^2 n} = -\frac{a^2}{4b(1 + n)^2}$$

6.5 Identifying the Area where $\hat{w}_{ma}[n]$ is preferred

First note that it has been shown in Appendix 6.2 that $\tau_{ma}[n]$ will never be played if $n \leq 1$. Consequently the following proof can be restricted to the set of $n > 1$.

The country size at the intersection of $\hat{w}_{ma}[n]$ and $\hat{w}_o[n]$ is found by subtracting $\hat{w}_{ma}[n]$ from $\hat{w}_o[n]$, setting this difference equal to zero and solving for n. Since $\hat{w}_{ma}[n]$, and consequently the difference between the two welfare functions, is a polynomial of degree eight, the regula falsi method is employed to find the real and positive root of this expression.

At the fixed point of $n = 1.40231$, $\hat{w}_{ma}[n]$ and $\hat{w}_o[n]$ intersect. Since $\frac{\partial \hat{w}_o[n]}{\partial n} > \frac{\partial \hat{w}_{ma}[n]}{\partial n}$ holds locally at $n = 1.40231$, welfare from $\hat{w}_{ma}[n]$ will be higher (lower) than welfare from $\hat{w}_o[n]$ iff $n < 1.40231$ ($n > 1.40231$) holds. Therefore, a necessary and sufficient condition for the first mover to prefer playing $\tau_{ma}[n]$ <u>over $\tau_o[n]$</u> is that $1 < n < 1.40231$ holds.

Given this necessary and sufficient condition holds, it still depends on the actual level of costs whether Home prefers to play $\tau_{ma}[n]$ or $\tau_i[\gamma, n]$ in this interval. The intersection of $\hat{w}_{ma}[n]$ and $\hat{w}_i[\gamma, n]$ at the point where $n = 1.40231$ can be solved for a cost level of $\gamma = 0.03086$. Speaking graphically with regard to Figure 3, litigation costs have to be lower than 0.03086 to shift the $\hat{w}_i[\gamma, n]$-curve so much downward that its intercept with the $\hat{w}_{ma}[n]$-curve lies in the interval of $1 < n < 1.40231$. Therefore, a necessary condition for the first mover to prefer playing $\tau_{ma}[n]$ <u>over $\tau_i[\gamma, n]$</u> is that $0 < \gamma < 0.03086$ holds.

6.6 Proof of Proposition 1

Let $n_{io}[\gamma]$ denote the market size ratio where the first mover switches from playing $\tau_i[\gamma, n]$ to playing $\tau_o[n]$. Hence it is the intersection of $\hat{w}_o[n]$ and $\hat{w}_i[\gamma, n]$ in the n-w-space, where $\hat{w}_i[\gamma, n]$ crosses $\hat{w}_o[n]$ from above (You may want to consider Figure 3.). It is found by setting the two corresponding welfare functions equal to each other and solving for n:[41]

$\hat{w}_o[n] = \hat{w}_i[\gamma, n]$

$\Leftrightarrow$

$$\frac{a^2}{b}\frac{(17+25n)}{64(1+n)} = \frac{a^2}{b}\frac{1}{18}(5 + \frac{1}{4(2+n)^2}(3(-12 - 6n + \sqrt{\alpha})(1 + \frac{1}{12n}((1+n)(12 + 18n - \sqrt{\alpha})))))$$

The resulting polynomial has eight roots in n, meaning that there are eight intersections of $\hat{w}_o[n]$ and $\hat{w}_i[\gamma, n]$. Four of them are complex, and four are real. The only root that is positive and real for $n > 1$ (Two other real roots are globally negative. Another real root is positive, but globally smaller than unity.[42]) is therefore $n_{io}[\gamma]$. It takes on the value 2.46187 for $\gamma = 1$ and the value 1.38504 for $\gamma = 0$. The local Taylor approximation of $n_{io}[\gamma]$ at a particular value of γ, with $0 < \gamma < 1$, is strictly increasing in γ. In other words, locally ($1.38504 < n < 2.46187$, $0 < \gamma < 1$) it holds that $\frac{\partial n_{io}[\gamma]}{\partial \gamma} > 0$.

The associated Mathematica files may be provided upon request.

6.7 Proof of Proposition 2

Let $n_{io}[n_p]$ denote the country size ratio, where the first mover switches from playing $\tau_i[n_p, n]$ to playing $\tau_o[n]$. Hence $n_{io}[n_p]$ is the equation for the value of n at the intersection of $\hat{w}_o[n] := \hat{w}[\tau_o[n], \tau_o^*[n], n]$ and $\hat{w}_i[n_p, n] := \hat{w}[\tau_i[n_p, n], 0, n]$ as a function of n_p. This function is found by setting $\hat{w}_o[n]$ equal to $\hat{w}_i[n_p, n]$ and solving for n:[43]

$\hat{w}_o[n] = \hat{w}_i[n_p, n]$

$\Leftrightarrow$

$$\frac{a^2}{b}\frac{4+45n+30n^2+5n^3}{8(1+n)(3+n)^2} = \frac{a^2}{b}\frac{1}{2(2+n)^2}(1 + 4n + n^2 + \frac{n((3+n)(2+3n)-\beta)}{2(3+n)} - \frac{(1+n)((3+n)(2+3n)-\beta)^2}{4n(3+n)^2})$$

[41] Where $\alpha = 18(4 + n(20 + 17n)) + 18(2 + n)^2\sqrt{1-\gamma} - (2+n)^2\gamma$.

[42] This positive real root, being smaller than unity, coincides with the lower switching point $n_{oi}[\gamma]$. This is due to the fact that welfare from both playing $\tau_o[n]$ and playing $\tau_i[\gamma, n]$ always has to coincide in $n_{oi}[\gamma]$ because the associated tariffs themselves are identical, and both do not trigger any retaliation at $n_{oi}[\gamma]$.

[43] Where $\beta = \sqrt{4 + n(100 + n(149 + 66n + 9n^2)) - \frac{8(2+n)^2(3+n)}{(2+n_p)^2(3+4n_p+n_p^2)} + 8(2+n)^2\sqrt{1 - \frac{(1+n)(2+n)^2(3+n)}{(2+n_p)^2(3+4n_p+n_p^2)}}}$.

For the case of prohibitive costs (i.e. $n_p = n$), it holds that $n_{io}[n_p] = 1.60254$. Hence any Home country of larger size than 1.60254 would play $\tau_o[n]$. In the other extreme case of no litigation costs (i.e. $n_p \rightarrow \infty$), $n_{io}[n_p]$ converges to 1.21280. Between these boundaries, the local Taylor approximation of $n_{io}[n_p]$ exhibits the following properties:

1. $\frac{\partial n_{io}[n_p]}{\partial n_p} > 0$ for all $n > 1.52790$

2. $\frac{\partial n_{io}[n_p]}{\partial n_p} = 0$ for all $n = 1.52790$

3. $\frac{\partial n_{io}[n_p]}{\partial n_p} < 0$ for all $n < 1.52790$

The associated Mathematica files may be provided upon request.

References

[1] Bagwell, K., and Staiger, R. W. An Economic Theory of GATT. *American Economic Review 89*, 1 (1999), 215–248.

[2] Bagwell, K., and Staiger, R. W. *The Economics of the World Trading System.* The MIT Press, Cambridge, Massachusetts and London, England, 2002.

[3] Becker, G. S. Crime and Punishment: An Economic Approach. *The Journal of Political Economy 76*, 2 (1968), 169–217.

[4] Bown, C. P. Participation in WTO Dispute Settlement: Complaints, Interested Parties and Free Riders. *World Bank Economic Review 19*, 2 (2005), 287–310.

[5] Busch, M. L., and Reinhardt, E. Developing Countries and General Agreement on Tariffs and Trade/World Trade Organization Dispute Settlement. *Journal of World Trade 37*, 4 (2003), 719–735.

[6] Footer, M. E. Developing country practice in the matter of wto dispute settlement. *Journal of World Trade 35*, 1 (2001), 55–98.

[7] Guzman, A. T., and Simmons, B. Power Plays & Capacity Constraints: The Selection of Defendants in WTO Disputes. *Journal of Legal Studies 34* (2005), 557–598.

[8] Horn, H., Mavroidis, P. C., and Nordström, H. Is the Use of the WTO Dispute Settlement System biased? *Centre for Economic Policy Research Discussion Paper Series 2340* (1999).

[9] Jordan, M. Sanktionsmöglichkeiten im WTO-Streitbeilegungsverfahren. *Hamburger Studien zum Europäischen und Internationalen Recht 41* (2005).

[10] Kennan, J., and Riezman, R. Do Big Countries Win Tariff Wars? *International Economic Review 29*, 1 (1988), 81–85.

[11] Kovenock, D., and Thursby, M. GATT, Dispute Settlement and Cooperation. *National Bureau of Economic Research Working Paper Series 4071* (1992).

[12] Maggi, G. The Role of Multilateral Institutions in International Trade Cooperation. *The American Economic Review 89*, 1 (1999), 190–214.

[13] NORDSTRÖM, H. The Cost of WTO Litigation, Legal Aid and Small Claim Procedures. *Discussion Paper at the 2005 Conference of the Center for World Affairs and the Global Economy (WAGE) at the University of Wisconsin, Madison* (2005).